pistils are such that each flower type may be pollinated by either of the other 2 flower forms. Moreover, the flowers are placed on the axis of the spike so nearly horizontal as to lessen the probability of self-pollination.

The microspores are ellipsoidal in form and the different sets of stamens show marked differences in size of pollen grains, the higher anthers having the larger pollen, the middle ones intermediate, and the short-stalked stamens the smallest spores. This relation suggests a correspondence with the 3 types of stigmas. Averaging a large number of spores it was found that the mean diameters of the 3 sizes of pollen grains were as 100, 80, and 51, and their volumes respectively as 100, 53, and 14. Recalling HALSTED'S work on *Eichhornia crassipes*, in which he found that all sizes of pollen grains germinated if given sufficient time, but that the larger spores germinated much more promptly than the smaller, HAZEN suggests that prompt germination would be of great advantage in the long-styled *Pontederia* flowers in which the flowers wither so quickly that a slow germinating spore might not have time to function.

The author lists observed insect visitors, naming 10 Lepidoptera and 4 Hymenoptera, the least skipper, *Ancyloxypha numitor* Fabr., being the most frequent visitor. Experimental work by the author is in progress on the relative fertility of the different flowers with various pollen combinations, and its publication is awaited with interest.—R. B. WYLIE.

Phototropism.—Miss PARR,[7] working in HOTTES' laboratory of the University of Illinois, has done an excellent piece of quantitative work on the response of *Pilobolus* to light. The literature on phototropism has been full of conflicting statements and theories, very largely due to the lack of quantitative work of the type done by Miss PARR. This work does much to show the reasons for these diverse views and to lay the foundations for substantial progress. The physics department of the University assisted in the control of the delicate instruments used in the measurements of light. It is very desirable at this stage of plant physiology that we get the more general cooperation of well-trained physicists and chemists to aid in transforming plant physiology from a qualitative to a quantitative science. The results of the work can best be presented by quoting the summary: (1) *Pilobolus* responds to the light of all regions of the visible spectrum; (2) the presentation time decreases gradually from red to violet, and there is no indication of intermediate maxima and minima; (3) the presentation time does not vary in direct ratio with the measured value of the energy of the light in the different regions of the spectrum; (4) the presentation time varies in inverse ratio to the square roots of the wave-frequency; (5) the product of the square root of the frequency times the presentation time decreases with the decrease in the energy value of the spectral regions and is an approximate constant for a given light source; (6) the spectral energy in its relation to presentation time may be expressed approximately in

[7] PARR, ROSALIE, Response of *Pilobolus* to light. Ann. Botany **32**:177–205. 1918.

the Weber-Fechner formula, if the wave-frequencies be made a function of the constant; (7) the relation of the spectral energy to the presentation time may also be approximately expressed in the Tröndle formula, the wave-frequency being made a function of the constant.—WM. CROCKER.

Breeding for disease resistance.—It has been a popular impression that newly produced disease resistant varieties will gradually lose their immunity in later generations. The idea was that such new varieties might sometimes become slightly infected; this short sojourn of the disease organism in the normally immune host would enable the former to adapt itself to the new conditions and gradually acquire virulence, until finally a new biologic form was developed to which the host in question was quite susceptible. EVANS[8] carried the same idea further when he found that a cross between resistant and susceptible races of wheat produced a hybrid even more susceptible to rust than the susceptible parent. Furthermore, rust from the hybrid could now infect the immune parent. Such facts were very discouraging, since they indicated that the artificial breeding of resistant crop plants is rapidly overtaken by the natural breeding of new biologic forms of the disease organism.

Particularly acceptable, therefore, is the work of STAKMAN, PARKER, and PIEMEISEL,[9] who find that wheats resistant to rust remain resistant regardless of the previous history of the rust; the gap between immune and susceptible varieties is not bridged by transitional varieties or by artificial hybrids. "Resistance is rather an hereditary character, which cannot be produced by the accumulation of fluctuating variations within a susceptible line, nor broken down by changes in the host or parasite." Acceptable as such a conclusion may be, both to commercial breeders and to academic geneticists, it is very questionable how widely it may be applied. It will be difficult, although not hopeless, to explain away much of the contrary evidence.—MERLE C. COULTER.

Nature of monocotyledonous leaves.—Mrs. ARBER[10] has presented the results of an anatomical investigation of the phyllode theory of the monocotyledonous leaf. According to DECANDOLLE, it is equivalent to the leaf-base and petiole of a dicotyledonous leaf, but Mrs. ARBER believes that certain monocotyledonous leaves are still further reduced in that they are equivalent to leaf-bases only. In case the monocotyledonous leaf shows a distinction of petiole and blade, HENSLOW suggested that the blade is merely an expansion

[8] EVANS, I. B. P., South African cereal rusts, with observations on the problem of breeding rust resistant wheats. Jour. Agric. Sci. 4:95–104. 1911.

[9] STAKMAN, E. C., PARKER, JOHN H., and PIEMEISEL, F. J., Can biologic forms of stem rust on wheat change rapidly enough to interfere with breeding for rust resistance? Jour. Agric. Research 14:111–123. *pls. 13–17.* 1918.

[10] ARBER, AGNES, The phyllode theory of the monocotyledonous leaf, with special reference to anatomical evidence. Ann. Botany 32:465–501. *figs. 32.* 1918.